AMSAA

TECHNICAL REPORT NO. 534

FRIENDLY FIRE AND COMBAT IDENTIFICATION IN GROUNDWARS

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U.S. ARMY MATERIEL SYSTEMS ANALYSIS ACTIVITY
ABERDEEN PROVING GROUND, MARYLAND

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Casualties due to friendly fire have always been a part of war, but typically have not been considered in combat simulations. Due to the battles fought in Desert Storm in which a high percent of the BLUE losses were attributable to friendly fire, the military community has focused more attention on the causes and prevention of fratricide. Combat Identification Devices (CID's) are being developed with the purpose of identifying friendly vehicles before engagement.

In an effort to support work in this area, the U.S. Army Materiel Systems Analysis Activity (AMSAA) has modified one of its combat simulations, Groundwars, to include the possibility of fratricide and the deployment of the proposed near term CID's. AMSAA has conducted a CID parametric study by varying the probability of correct identification, system timelines and vulnerabilities, and scenarios.

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1. Introduction

Casualties due to friendly fire have always been a part of war, but typically have not been considered in combat simulations. Due to the battles fought in Desert Storm in which a high percent of the BLUE losses were attributable to friendly fire, the military community has focused more attention on the causes and prevention of fratricide. Combat Identification Devices (CID) are currently being developed with the purpose of identifying friendly vehicles before engagement.

In an effort to support work in this area, the U.S.Army Materiel Systems Analysis Activity (AMSAA) has modified one of its combat simulations, Groundwars, to include the possibility of fratricide and the deployment of CIDs. The CIDs which were modeled reflect the proposed near term solutions to the problem. Future technologies may require additional methodology enhancements and further study of the benefits of those changes. This report documents the methodologies for fratricide and combat identification and shows the results of a parametric study which was conducted to assess the potential benefit of deploying generic CIDs.

2. Model Development

2.1 Groundwars Model

Groundwars is a weapon systems effectiveness model which provides the results of a land duel between two forces. The model simulates individual weapon systems and employs Monte Carlo probability theory as its primary solution technique. The simulation is stochastic and event sequenced.

Groundwars is an outgrowth of the TANKWARS model (version II) originally written by Mr. Fred Bunn of the Ballistic Research Laboratory (BRL), Aberdeen Proving Ground, Maryland. The current version of the model is Groundwars Version 5.0.[1]

The model is generic, and the user defines the platforms, rounds, and sensors to be simulated. The user also determines the size of the two opposing forces, the range at which the battle will begin, the attack angle distribution, and the terrain statistics to

[1] M. Schmidt, L. Harrington, B. Burns, "Groundwars Version 5.0 User's Guide," AMSAA Technical Report No. xxx, August 1992.

be used.

Prior to the modifications documented in this report, the Groundwars model simulated battles in which an observer could detect and engage only enemy units. When an observer acquired a target, he knew that it was enemy. He would immediately engage that target with there being no chance of killing a friendly unit.

2.2 Fratricide Methodology

The model has been changed to allow observers to detect and engage both enemy and friendly units. When an observer detects a target, there is a chance of that target being a friendly, and therefore the observer has a decision to make whether or not to engage. This decision may be based on the target's posture, aspect angle, movement, and/or the location of the target in reference to the observer. It may also be based on the observer's awareness of his position and other friendly positions on the battlefield. Associated with this decision to engage is a time delay. The model has been changed to reflect this decision process.

It is also possible that the observer is able to identify the detected target through his target acquisition device. If the observer detects AND identifies the target, the previously mentioned decision process will not take place. If the target is an enemy, the observer will begin the engagement. If the observer identifies the target as friendly, he will begin searching for other targets. At this time the model does not account for a false sensor identification by the observer.

The figure to the right shows the four possible results of the fratricide methodology. The first two are the situations in which an observer has detected a target, but cannot identify it. For both cases the decision time delay is assessed, and the observer's normal search pattern is interrupted. For the first of these two timelines, the observer has decided that the risk is too high, and he disengages the target because it may be friendly. For the second case, the observer makes the decision to fire at the target. In the third case the observer has detected a friendly unit and can identify it as friendly through his sensor. The

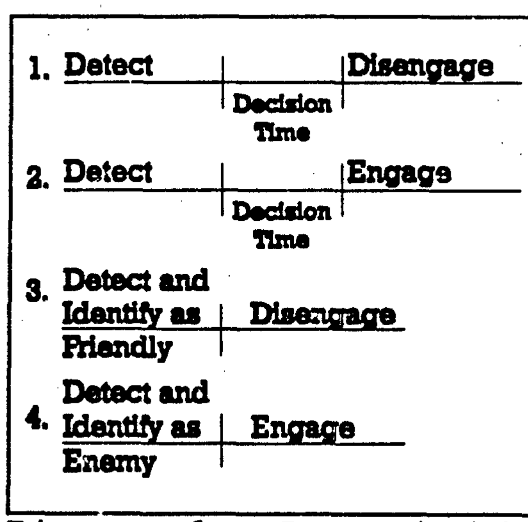

Figure 1 Fratricide Methodology Possible Results

observer disengages the friendly target and continues searching for additional targets. The final timeline accounts for the situation in which the observer has detected and identified the target as an enemy. In this case, the decision time is not assessed and the observer begins firing at the enemy.

2.3 Query-Response CID

The first type of CID which was modeled is a query and response system, which is activated after an observer detects a target and decides to fire. Just prior to firing at the target, the firer queries the target (laser, RF, or MMW), and tries to elicit a response from the target. The query is placed just before the firing of the weapon because the user (U.S. Army Armor School) wanted the CID to not interfere with the normal firing sequence of the gunner. If the target receives the signal and interprets it correctly, he will return a response to the firer. If the firer receives the reply and interprets it correctly, he will discontinue the firing sequence, disengage the target, and begin searching for new targets. This sequence of interrogate and reply requires some finite period of delay time which may lengthen the engagement times of the firer.

Within the model the query-response process is modeled as a time delay and a series of probabilities. The CID time delay and the probabilities are a function of the distance between the firer and the target. Given that an observer has detected a target and is going to engage, the aiming time is assessed and a fire event is scheduled. A time from a normal distribution about the CID time delay is drawn and inserted into the aim time. The fire event is postponed by this amount of time. A CID query event is scheduled at the point in time within the aim time.

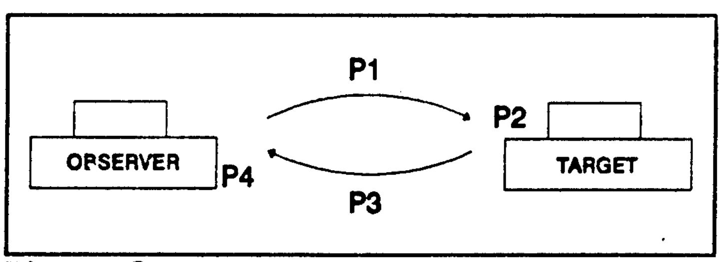

Figure 2 Query-Response Probabilities

When the CID event occurs, the four probabilities shown in the figure below determine if the query-response cycle is successful. The first is the probability that the query will reach the target, and the second is the probability that the target will detect the query and properly react to it. The third is the probability that the target's response will reach the firer, and the fourth is the probability that the firer will properly interpret the response. Monte Carlo draws against each of these probabilities determines success or failure. A failure to meet any one of these draws means that the entire CID attempt

failed. If the CID is successful the fire event is cancelled and the observer restarts his search process. If the observer's CID fails to identify the target, he will fire at the target at the scheduled time.

The methodology was written to allow an observer to query a target a second, third, or more time to try to get a response. For each subsequent query, the CID time delay is assessed, the fire event is further moved back, and Monte Carlo draws are made against the four probabilities to determine success or failure.

The CID code is only used at the beginning of an engagement. The firer only queries a target prior to firing and is not able to query a target again in the middle of an engagement. Once he begins to fire, he will continue to fire until he is finished engaging this target.

2.4 Constant Emitter

The second type of CID is one which constantly emits a signal. When a friendly firer detects one of these emitting vehicles there is a chance that he will get the signal and realize that the target is friendly. Since this CID signal is always there, no time delay was modeled for this type of CID. The observer detects and immediately he may see the CID signal. There is also the chance that this CID signal may be a cue for detection similar to a firing signature. To model this cueing effect, there is a chance that searching observers will detect the emitting vehicles because of this signal; these observers may be friendly or they may be enemies with the correct receiver to detect the CID signal.

In terms of modeling, this CID type had two major aspects which needed to be addressed. The first aspect is the positive identification given that a friendly observer detects a friendly target. When the observer detects a target through normal search a Monte Carlo draw determines if he is able to identify the target as friendly. For this type of CID, a second attempt at identifying was not modeled since there is no active questioning involved. When the target is detected, it will either be identified or not based on the single draw.

The second aspect which needed to be addressed is detection by observers of the CID signal as a cue for detection. Since the model is event driven, the constant emission was modeled as a series of flash events which occur at regular intervals. The user defines the time between these flashing events. The user also defines the probability of each observer type being able to detect the CID "flash" given the period of time which elapses between flashes. At the scheduled time, a vehicle flashes and each observer with line of sight has a chance to detect the flashing.

Monte Carlo draws determine success or failure. For a friendly observer a success means that he has not only detected the friendly target, but also has identified the target as friendly.

There are two main differences between the two CID types. The first difference is the point in the acquisition/engagement timelines they operate. The next figure shows the timelines for the two CID types. For the query-response system, the observer detects, decides to engage, and is about to fire. (Recall that the firer's query was placed just prior to firing because the customer did not want the CID to interfere with the firer's normal firing sequence. The CID was placed at the point in the sequence when the gunner would normally be querying the target to get range, and therefore the CID would require no additional steps.) After the time delay for the query-response cycle, he gets the information that the target is friendly and he begins searching for new targets. This placement of the CID query may be moved as technologies develop. With the constant emitter system, the firer receives the CID information early in the acquisition process and the observer does not spend time deciding to engage or aiming.

The second main difference is that for the constant emitter the observer is given only one chance to CID the target. For the query-response CID, the observer can query the target multiple times if the first attempt(s) were not successful.

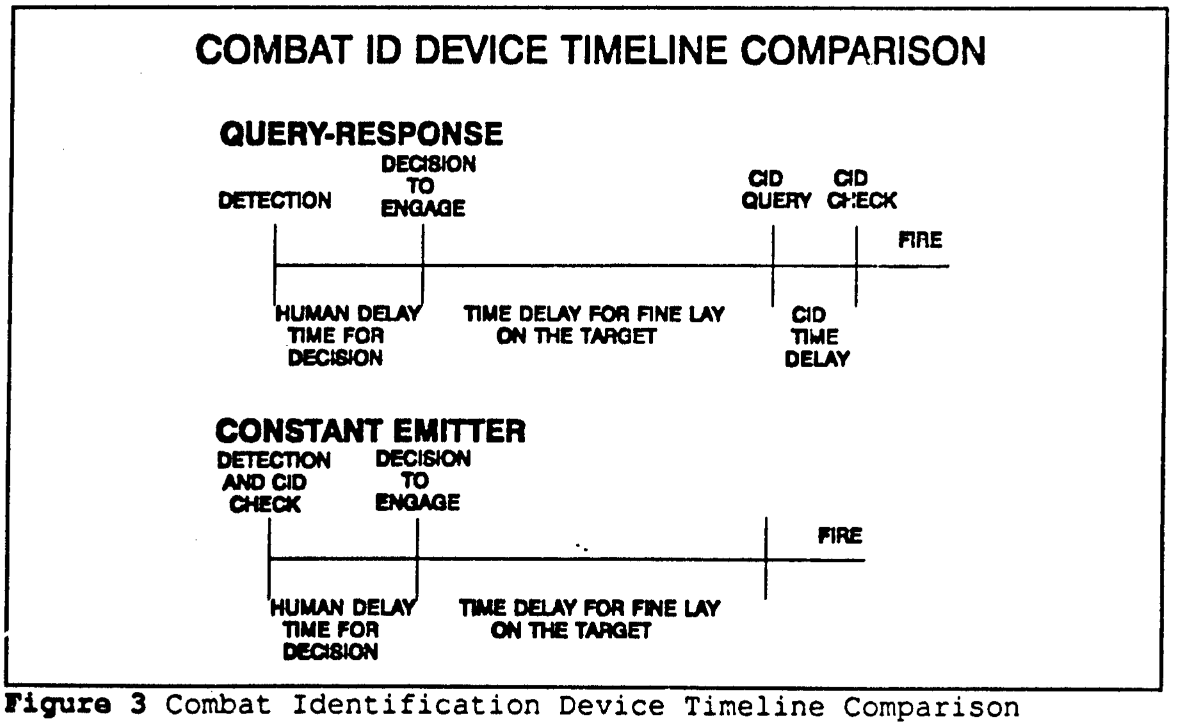

Figure 3 Combat Identification Device Timeline Comparison

3. Parametric Effectiveness Study

3.1 Study Parameters

Scenarios

Two scenarios were simulated for this study. The first scenario is a RED ambush in which 30 BLUE infantry vehicles are ambushed as they maneuver. Fratricide is introduced when a BLUE tank platoon sees the gun flashes and thinks that they are the targets of the fire. They turn and begin engaging both the RED and BLUE infantry units. Due to the close proximity of the RED and BLUE infantry vehicles the BLUE tanks cannot distinguish between the two and friendly losses result.

The second scenario is a deliberate RED offense in which a RED tank company attacks a BLUE defensive position. The RED force also includes an mechanized infantry squad in overwatch. The BLUE defensive force includes tanks and infantry vehicles. From across unit boundaries, a BLUE tank squad is retreating just ahead of the RED tanks. Since these tanks are retreating, the assumption was made that they would not fire at the BLUE defensive force. However, the BLUE defensive force is firing at the retreating units.

Graphical representations of the scenarios are shown in the next two figures. In each of the figures, the arrows indicate which units are able to detect and engage the other units. For both of these scenarios the atmospheric visibility range was 1 km. The BLUE vehicles were equipped with Forward Looking Infrared (FLIR) acquisition sensors and the RED vehicles had Direct View Optics (DVO).

CID Effectiveness

For both types of CID, the probability of correct CID was varied from 0.0 to 1.0 in increments of 0.1. For the query-response CID, the associated time delay was set at 0, 2, 5 and 10 seconds to examine the effects of lengthening the engagement timelines. The ability of the threat to intercept the CID signals was also played.

Engagement Doctrine

For the purposes of this study, three engagement doctrines

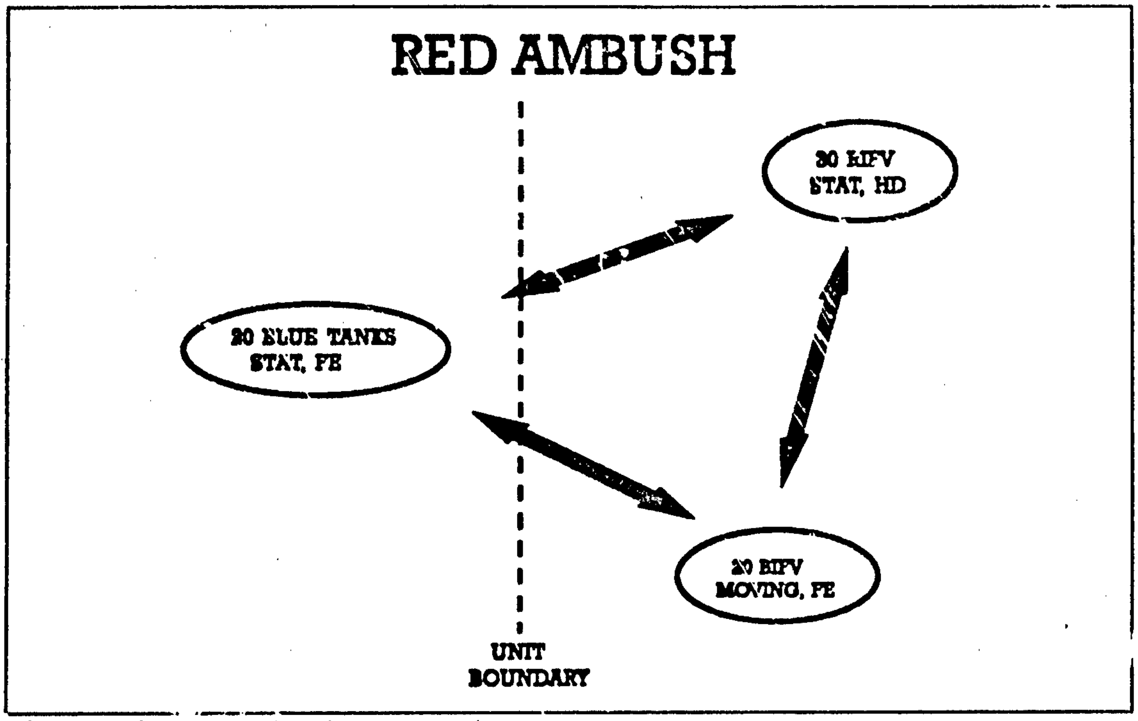

Figure 4 RED Ambush Scenario

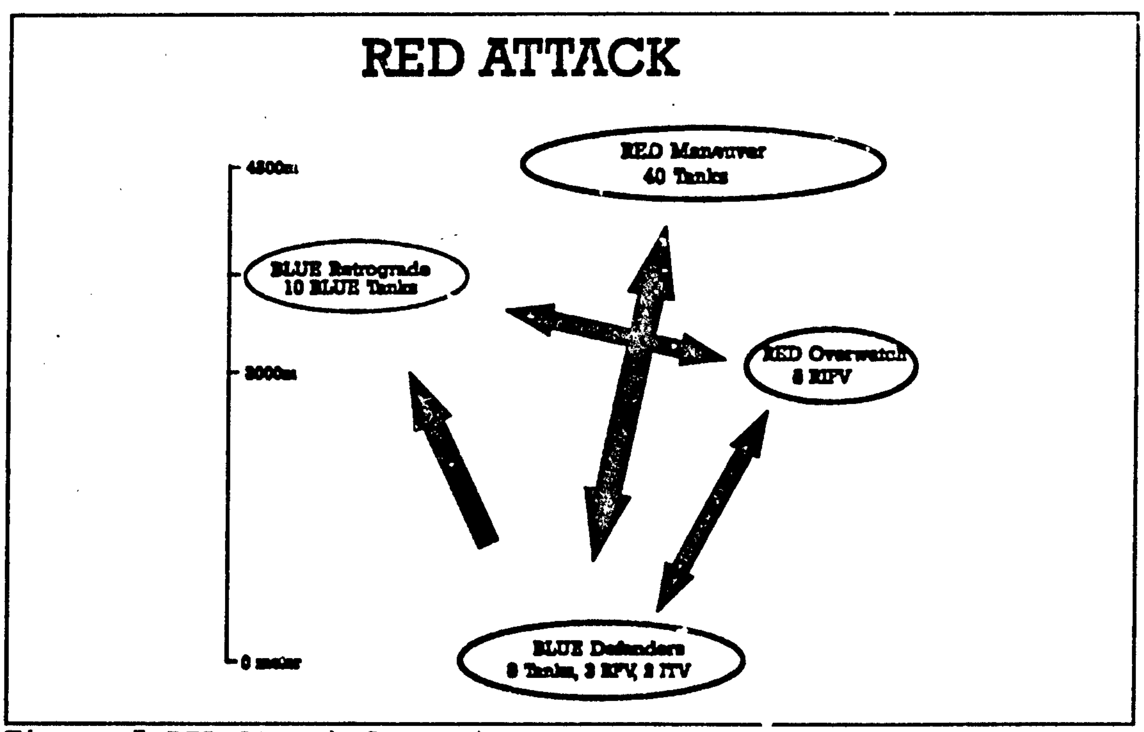

Figure 5 RED Attack Scenario

were defined which relate to situational awareness and friendly fire. These doctrines are labeled as Ground Weapon Control Status (1,2,3) in the charts. For the first doctrine (GWCS 1), BLUE units will detect a target and initiate engagement of that target. For the query-response CID, the firer will query the target a single time, and if the correct response is not received he will fire at the target. For the constant emitter CID, the firer will fire at the target if he does not get the friendly signal at the time of detection. If there were little chance of a detected target being friendly this doctrine would be used.

For GWCS 2, the process for the constant emitter CID is the same as GWCS 1. GWCS 2 is different for the query-response CID. Instead of a single query on the target, the firer will query the target a second time if he got no response to the first query. As soon as the firer gets a friendly response he will disengage the target. If there were a higher chance that friendly units were in the target area, GWCS 2 would be used to try to give the target a second chance to respond to the query.

GWCS 3 does not include either of the CIDs. For this doctrine, the firer will not engage a detected target unless he can identify the target as an enemy through his acquisition sensor. This doctrine would be used in situations where there is a very high likelihood that friendly units are in the target area, and the risk is too high to engage without positive enemy identification.

3.2 Measures of Effectiveness

Three main measures of effectiveness were examined for the evaluation: total BLUE losses, friendly BLUE losses, and force exchange ratio (total RED losses divided by total BLUE losses). In each of the charts, the BLUE losses will be shown as a bar relative to the scale on the left. The BLUE losses will be divided into BLUE losses due to enemy fire, and due to friendly fire. The exchange ratio will be shown as a point relative to the scale on the right. For some of the figures, the percent of BLUE losses which were due to friendly fire is shown over the bars.

3.3 RED Ambush Results

Probability of Acquisition and Identification

Figures 6 and 7 show the sensor performance for the BLUE tanks and the BLUE IFV respectively. The first figure shows the BLUE IFV sensor performance against the BLUE tanks and the RED IFV. The second is for the tanks against the BLUE and RED infantry vehicles.

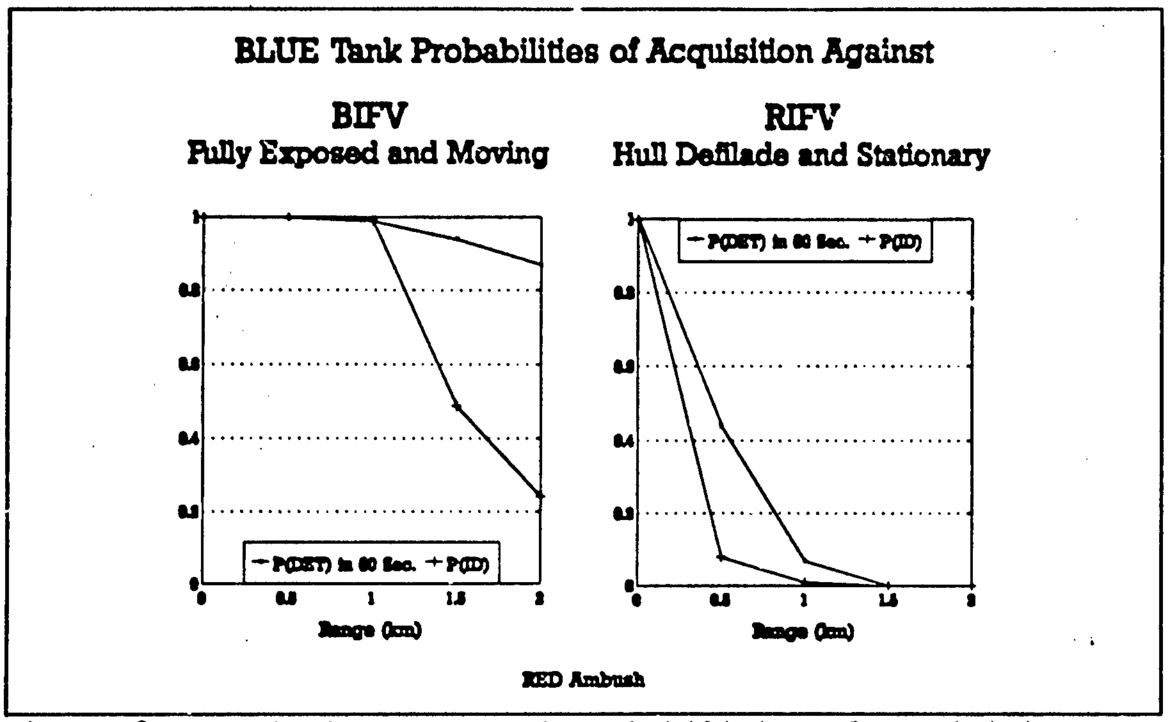

Figure 6 RED Ambush - BLUE Tank Probabilities of Acquisition

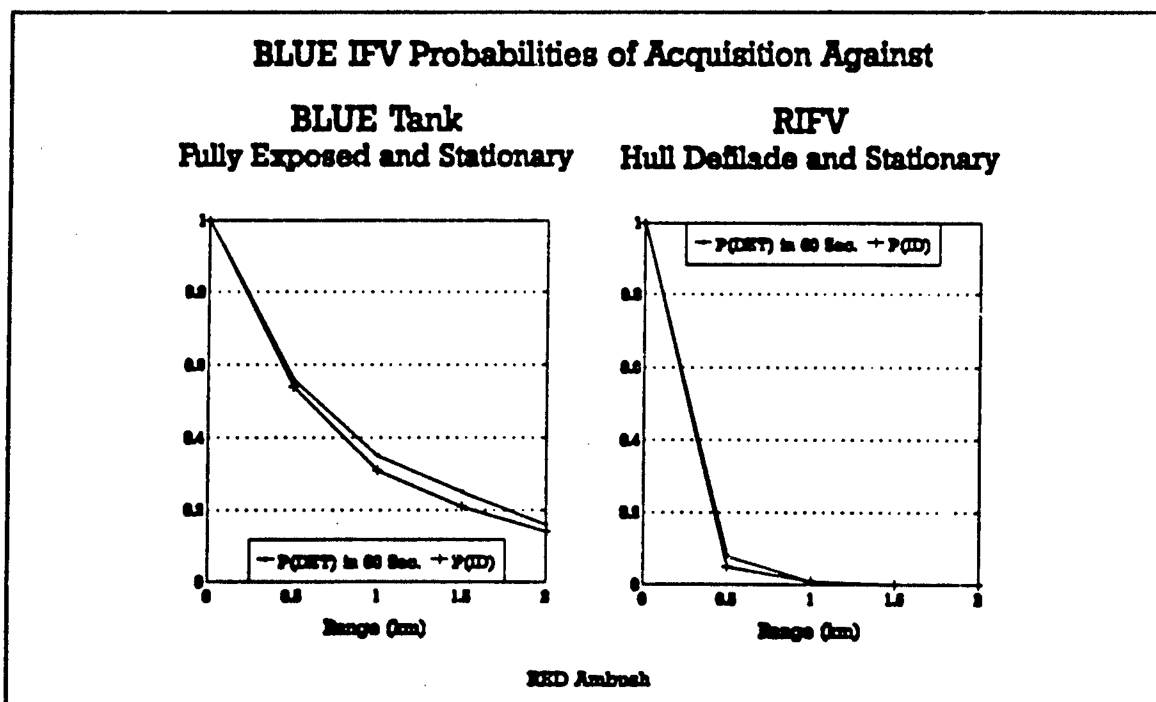

Figure 7 RED Ambush - BLUE IFV Probabilities of Acquisition

In each figure, there are two curves against each target. The first curve is the probability of detection in 60 seconds and the second is the probability of sensor identification of the target. The area between these two curves is the area in which BLUE is able to detect but not identify and therefore the possibility of fratricide exists when the target is BLUE.

Probability of Kill

The next figure shows the probability of kill given a shot for the BLUE weapons against both the BLUE and RED target. The BLUE tanks fired kinetic energy rounds at all targets. The probability of kill is much higher against the BLUE IFV's since they are fully exposed whereas the RED IFV's are hull defilade and are difficult to hit. The BLUE IFV's were firing an anti-tank guided missile (ATGM) against the tanks, and a 25 mm bullet at the RED IFV's.

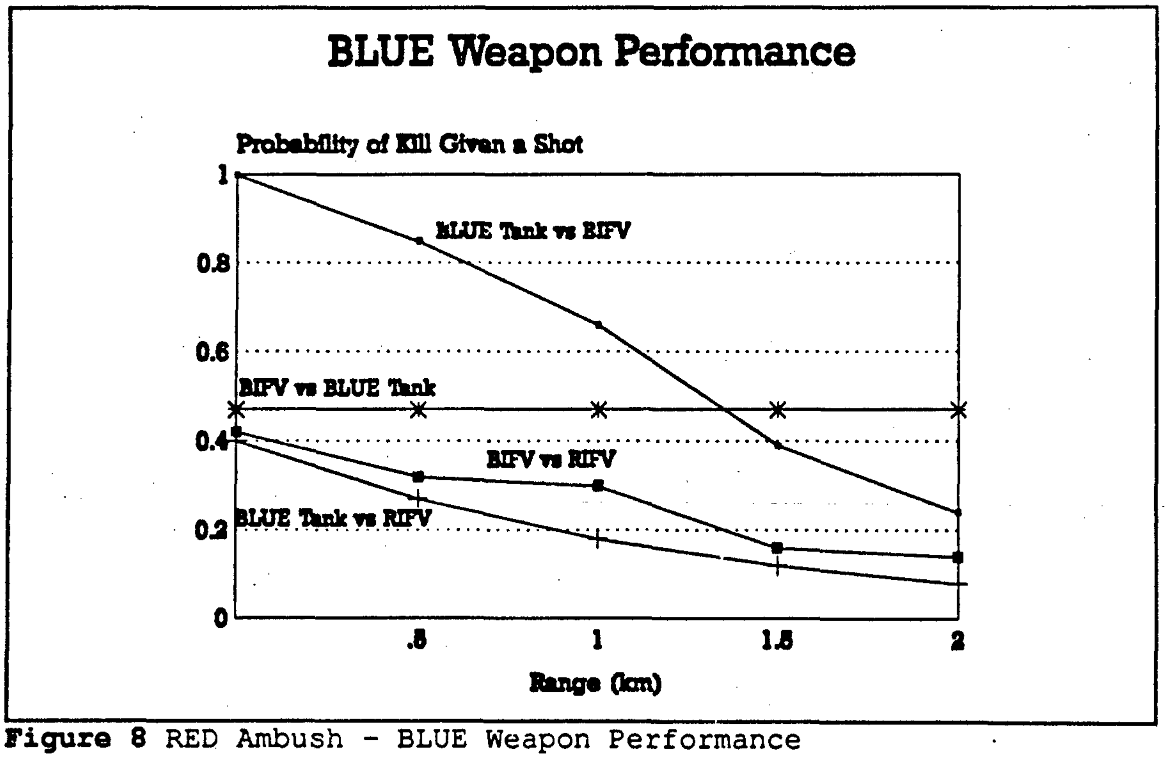

Figure 8 RED Ambush - BLUE Weapon Performance

Query-Response CID

Figure 9 shows the results for GWCS 1. The first bar on the left is the base case in which BLUE had no CID capability. In this case twenty one percent of BLUE's total losses were caused by friendly fire. The rest of the chart shows the results for cases in which the BLUE units were equipped with query-response CID's with varying levels of effectiveness. The time delay associated with the CID is 2 seconds for all of these cases. Each increase in CID effectiveness reduces the percentage of BLUE losses which were due to friendly fire. At the fifty percent CID effectiveness level the number of friendly fire losses has dropped from around 6 in the base case to 3.3. CID levels at or below fifty percent are not significantly increasing BLUE's force exchange ratio. At the sixty percent level the exchange ratio begins to rise. Increases in CID effectiveness above the eighty percent level do not substantially change the exchange ratio, but do continue to reduce the percent of friendly fire losses.

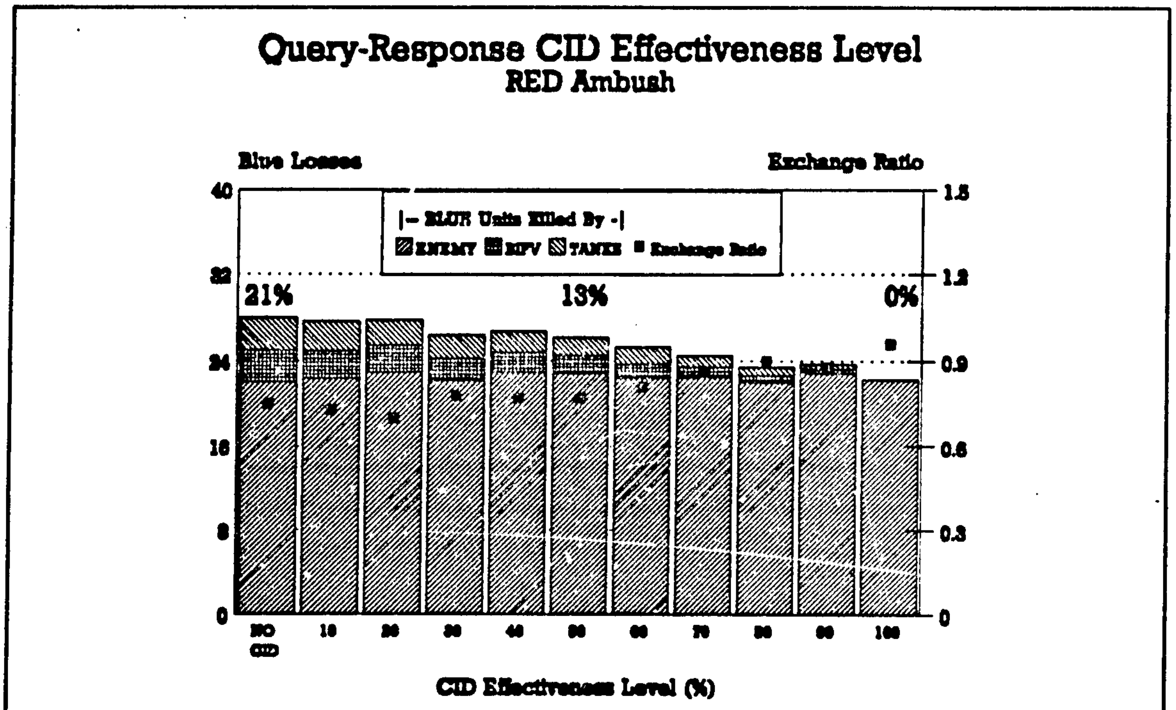

Figure 9 RED Ambush - Query-Response CID Effectiveness - GWCS 1

For Figure 10 the time delay associated with the query-response CID was varied. Aside from the baseline 2 seconds/query, three additional time delays were simulated. The ideal time delay of 0 seconds, as well as 5, and 10 seconds per query were simulated. The figure shows the results for these four

time delays at the 50, 80, and 100 percent CID effectiveness levels. For each level of CID effectiveness there was minimal difference between the 0 and 2 second time delay cases. The 5 and 10 seconds time delays begin to minimize the benefit which BLUE is getting from deploying the CID. At the fifty percent CID level, both the 5 and 10 second delays cause BLUE's force exchange ratio to drop below the base case. At the eighty percent CID level, the 10 second delay has the same effect. Even when the CID is perfect, the longer time delays are forcing BLUE's effectiveness down. Although these longer time delays cause BLUE's exchange ratio to drop, the total number of BLUE losses in every CID case is still lower than in the base case.

In Figure 11 the RED IFVs have a zero and five percent chance of detecting the BLUE vehicles when they respond to being queried. For each of the three levels of CID effectiveness there is no significant change in either BLUE's force exchange ratio or BLUE losses. If there is any change, it is that BLUE does slightly better when the threat has the chance of detection. In the normal battle without the threat detection, the RED units are closer to and are more likely to detect the BLUE IFVs which are moving. When there is the chance that RED will detect the CID response, the RED units detect more of the BLUE tanks than in the base case. When the RED units spend more time engaging the BLUE tanks, it allows the BLUE IFVs to die less and to kill more RED IFVs. For the threat detection cases, the BLUE IFVs are killing about 1 more RED vehicle than in the base case, and the total BLUE losses is staying about the same.

In Figures 12 and 13 BLUE queries twice with his CID under GWCS 2. The results show steady decreases in fratricide as the CID effectiveness level increases. Again the BLUE losses caused by the enemy remain steady. At the fifty percent effectiveness level, the percent of total BLUE fratricidal losses has dropped to 8 percent (under GWCS 1 this number was 13 percent). Beyond the sixty percent effectiveness level, there is limited added benefit. The percent of fratricide continues to drop slightly between sixty and eighty percent, but at both the ninety and one hundred percent level the losses due to friendly fire are 0. Beyond the sixty percent effectiveness level, the force exchange ratio changes only slightly.

Varying the CID time delay under GWCS 2 showed similar trends to those seen under GWCS 1. BLUE's force performance drops both in terms of total BLUE losses and force exchange ratio as the time delay increases. In comparison to Figure 10 the total BLUE losses have dropped for the fifty and eighty percent CID effectiveness levels due to the decrease in friendly fire losses achieved from querying a second time. For the fifty percent CID the exchange ratio has also increased. The results from the one hundred percent CID are nearly the same as under GWCS1.

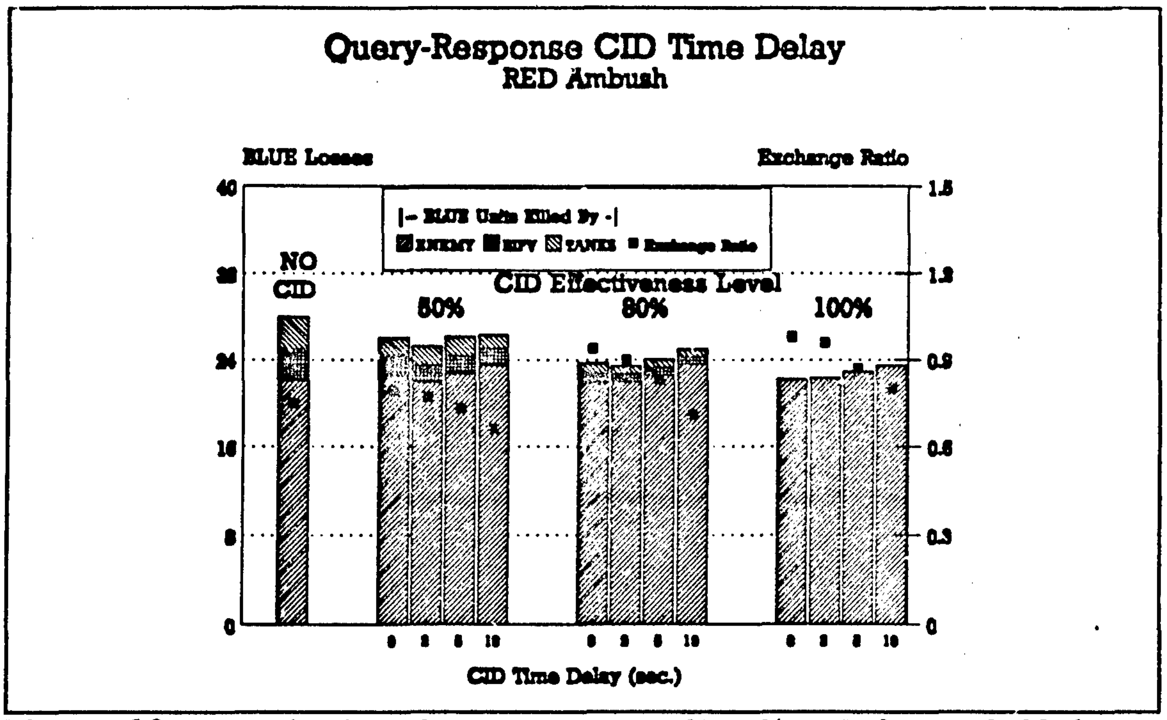

Figure 10 RED Ambush - Query-Response CID Time Delay - GWCS 1

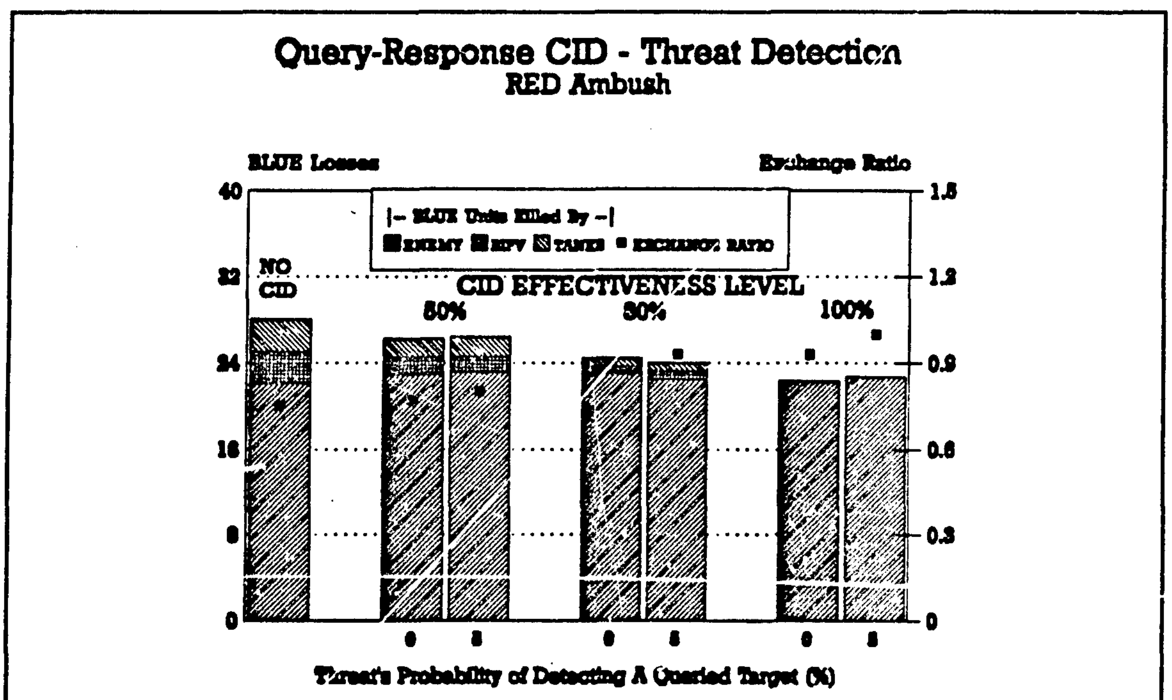

Figure 11 RED Ambush - Query-Response CID Threat Cueing - GWCS 1

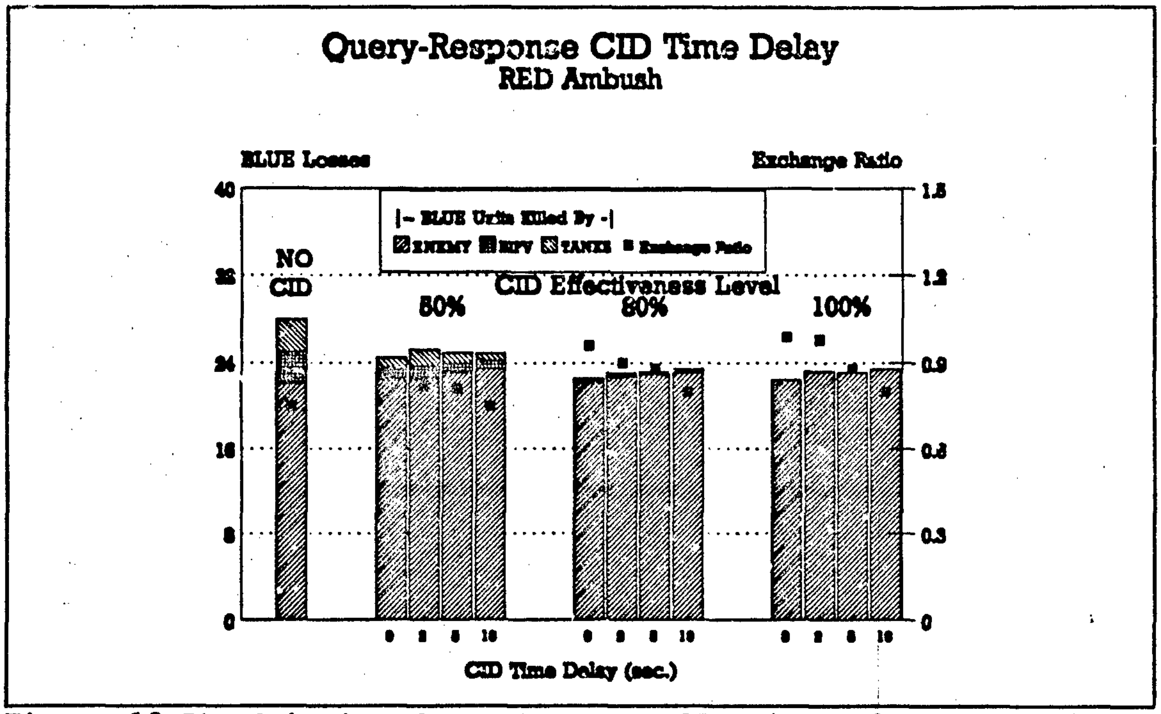

Figure 12 RED Ambush - Query-Response CID Time Delay - GWCS 1

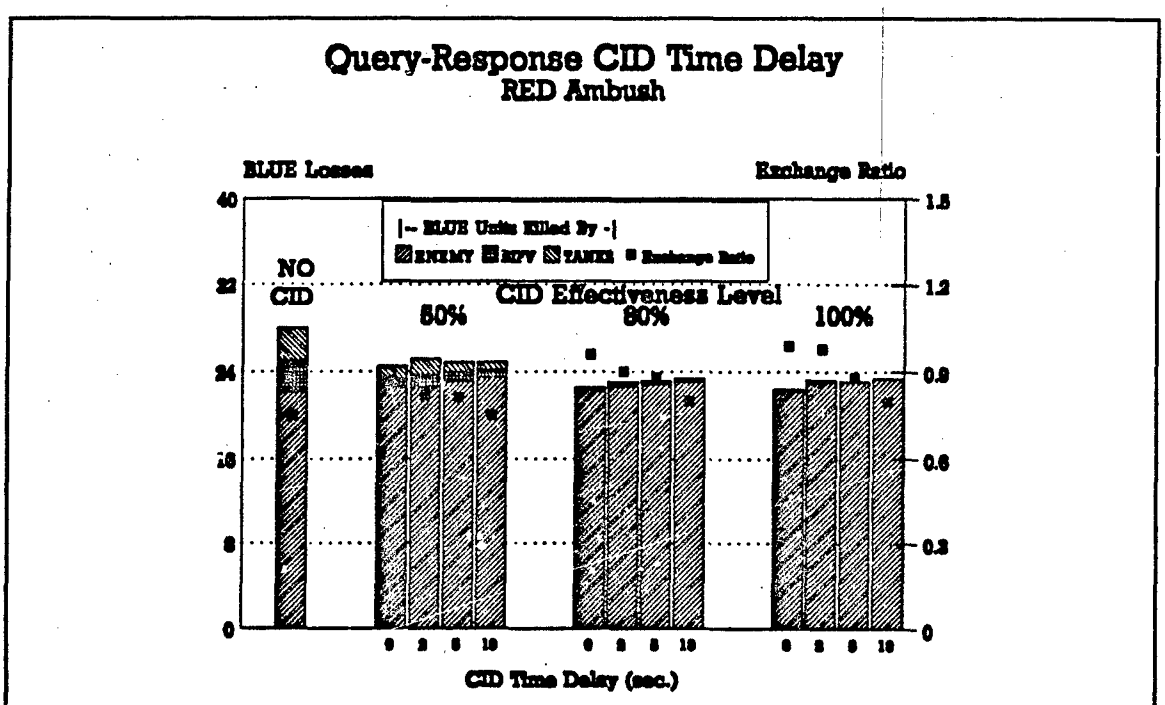

Figure 13 RED Ambush - Query-Response CID Threat Cueing - GWCS 1

Constant Emitter

When BLUE deploys a constant emitter CID, Figure 14, the results are nearly the same as the query-response results under GWCS 1. At the fifty percent CID effectiveness level the percent of friendly fire losses has dropped to 13 percent. In terms of total BLUE losses, friendly fire losses, and force exchange ratio the two types of CID perform equally well.

Figure 15 shows the effectiveness of the constant emitter when the threat is able to detect the CID signal being emitted by the friendly vehicles. From the methodology recall that associated with the constant emitter CID is a probability that threat systems will be able to intercept the CID emittance and to detect the vehicle which is emitting. This is modeled as a flashing effect (the vehicle "flashes" every 60 seconds), and observers in the battle have some probability of detecting these flashes. For the cases in the figure, the threat was given a zero (base case) and five percent chance of detection every 60 seconds. As you can see this ability of the threat to intercept significantly reduces BLUE's force effectiveness and increases total BLUE losses. This is in direct contrast to the query-response cases in which RED was able to detect the CID response of the targets. This difference is caused by the fact that in the query-response cases only those

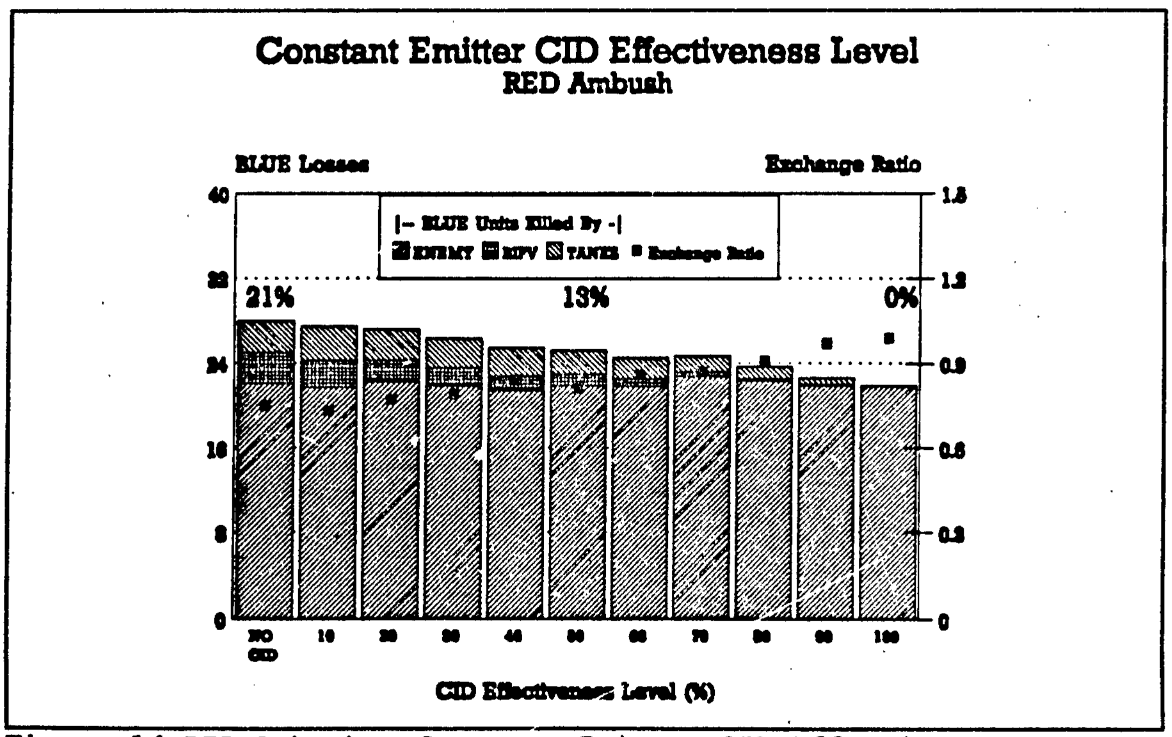

Figure 14 RED Ambush - Constant Emitter CID Effectiveness

vehicles which are queried are susceptible to being detected. In the constant emitter case all of the BLUE units are detectable from the start. This allows the RED units to detect and kill the BLUE tanks early in the battle before the BLUE IFV's have moved to a range at which they can readily kill the enemy.

As a summary, Figure 16 shows a comparison of the two types of CID. The performance of the query-response under GWCS 1 and the constant emitter are nearly the same for the three levels of effectiveness shown in the figure. When GWCS 2 is used for the query-response CID, the total BLUE losses and friendly fire losses drop for the fifty and eighty percent levels of effectiveness. This drop is not seen in the one hundred percent case, since there is no benefit to querying twice with a perfect system. The last bar in the figure shows the results of using GWCS 3 (BLUE will only initiate engagement when the target has been identified as an enemy through the BLUE sensor). This case resulted in the lowest total BLUE dead in the figure. It also results in the lowest exchange ratio. In this case, the BLUE tanks are not participating and are not killing the RED IFVs because the tanks are not able to identify the RED IFVs. Since the tanks almost never fire, the RED IFVs never return fire, and the battle is between the RED and BLUE IFVs. The result of the battle is that all of the BLUE IFVs are dying and a third of the RED IFVs are dying, but the BLUE tanks do not kill or die.

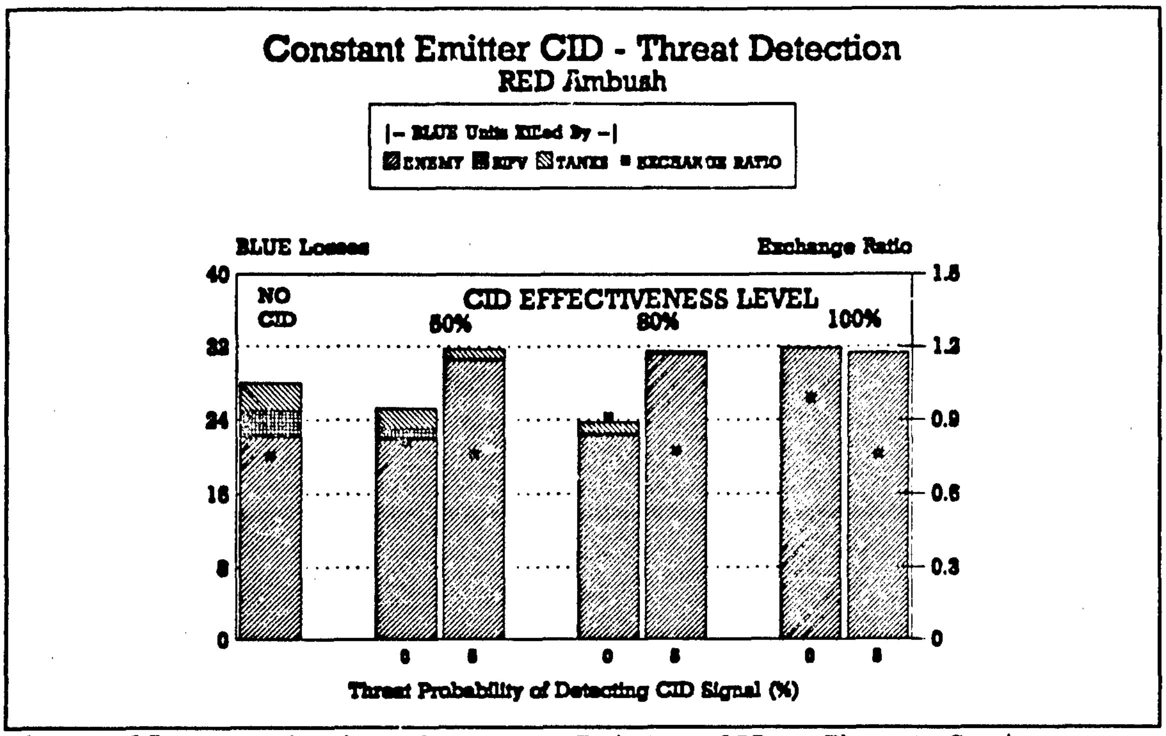

Figure 15 RED Ambush - Constant Emitter CID - Threat Cueing

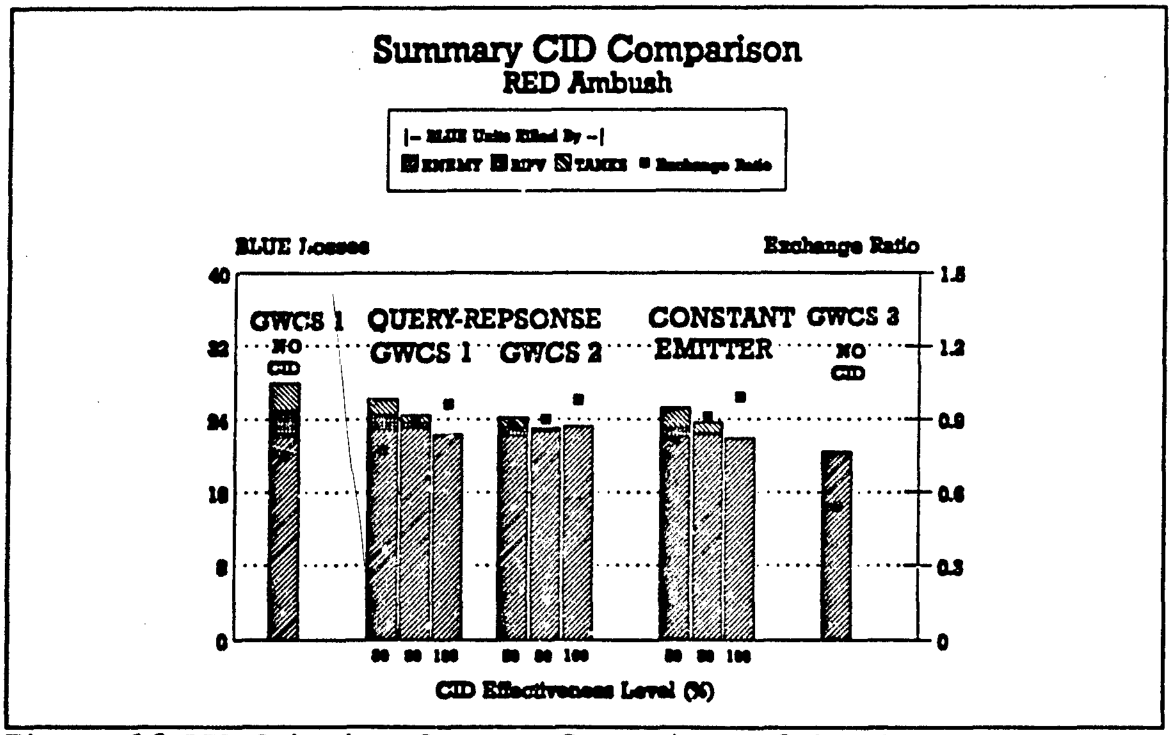

Figure 16 RED Ambush - Summary Comparison of CID Types

3.4 RED Attack Results

Probability of Acquisition and Identification

The sensor performance for the two BLUE sensors is shown in Figures 17 and 18. Again the two curves against each target are the probability of detection and the probability of identification. For each BLUE sensor there are three possible targets: RED tanks, RED overwatch, and BLUE retreating tanks. The probabilities of acquisition are the same against the RED and BLUE tanks since they are both fully exposed and moving. The RED overwatch vehicles are in hull defilade and are stationary which makes them hard to detect and impossible to identify.

Probability of Kill

Figures 19 and 20 show the probabilities of kill given a shot for the BLUE tank kinetic energy round and the BLUE IFV missile rounds against the two RED targets and the retreating BLUE tanks. In figure 19 the BLUE tank KE has a maximum firing range of 3000 meters. For this reason it is unable to shoot at the RED overwatch unit which is 3500 meters from the defensive position. The BLUE ATGM fired from the two BLUE IFV units can reach and kill the overwatch unit. The BLUE IFVs fired the same ATGM at all targets, but have different probabilities of kill because of differences in the probabilities of hit.

Query-Response CID

Figure 21 shows the query-response CID performance at the different levels of effectiveness. In the base case, 17 percent of BLUE's total losses were friendly. Recall that only the retreating BLUE tanks are being killed by friendly fire in this scenario. The exchange ratio changes from around 3.7 in the base case to 4.6 in the 100 CID effectiveness level for an increase of around 25 percent. BLUE total losses drop approximately 20 percent from the base case. This decrease in BLUE losses is solely reflected in the reduction in the percentage of friendly fire losses. The number of BLUE vehicles being killed by the enemy remains constant over the span of effectiveness levels. The time delay associated with the CID is 2 seconds for all of these cases.

The variations in time delay from the previous scenario were also played for the RED attack. In this scenario, the defenders are the ones who are going to be affected most by the increases in their engagement timelines. The retreating tanks are only engaging the RED overwatch and the added time delay does not substantially

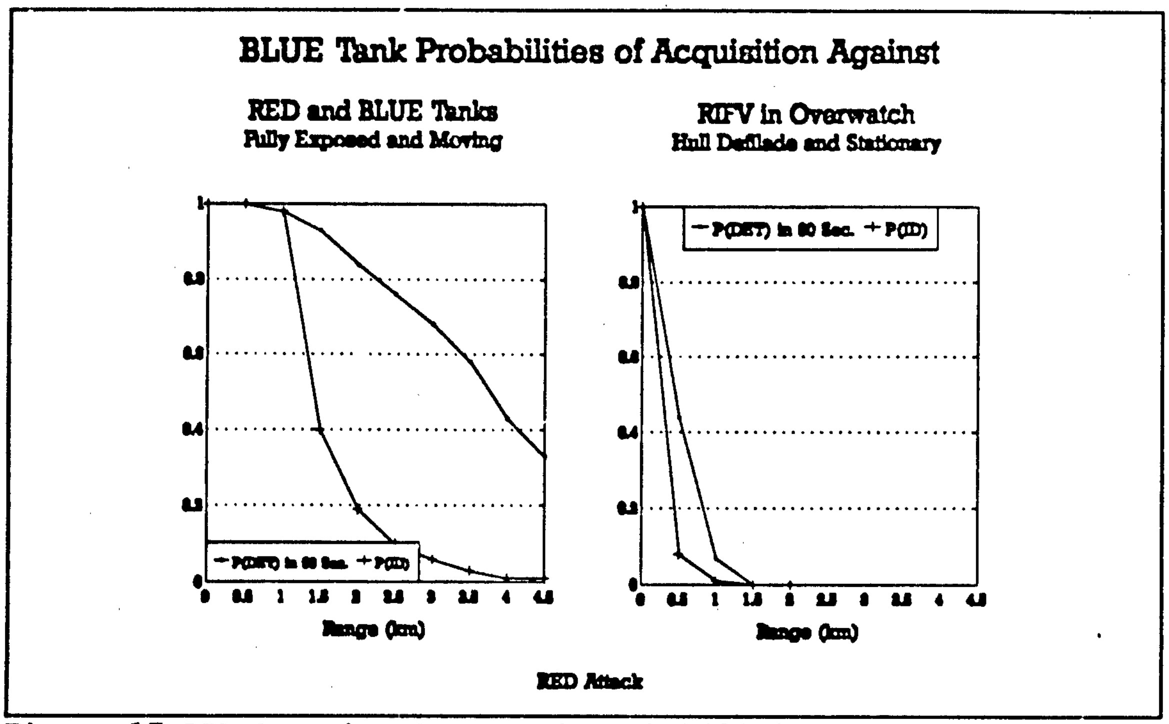

Figure 17 RED Attack - BLUE Tank Probabilities of Acquisition

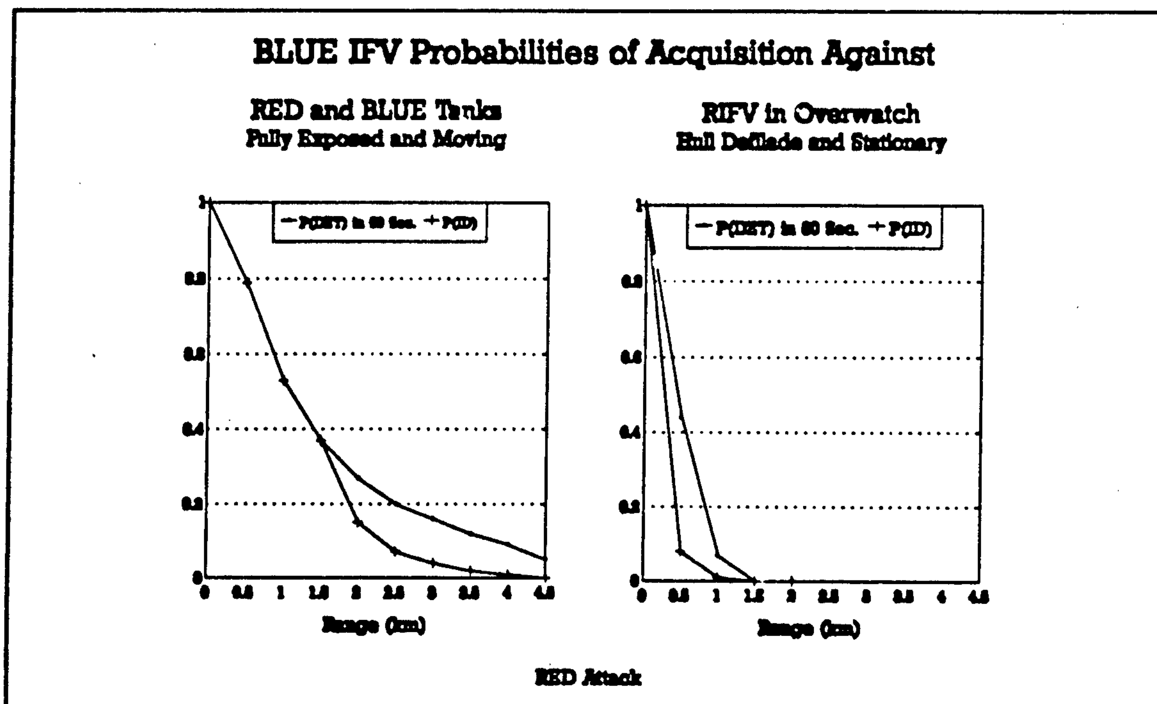

Figure 18 RED Attack - BLUE IFV Probabilities of Acquisition

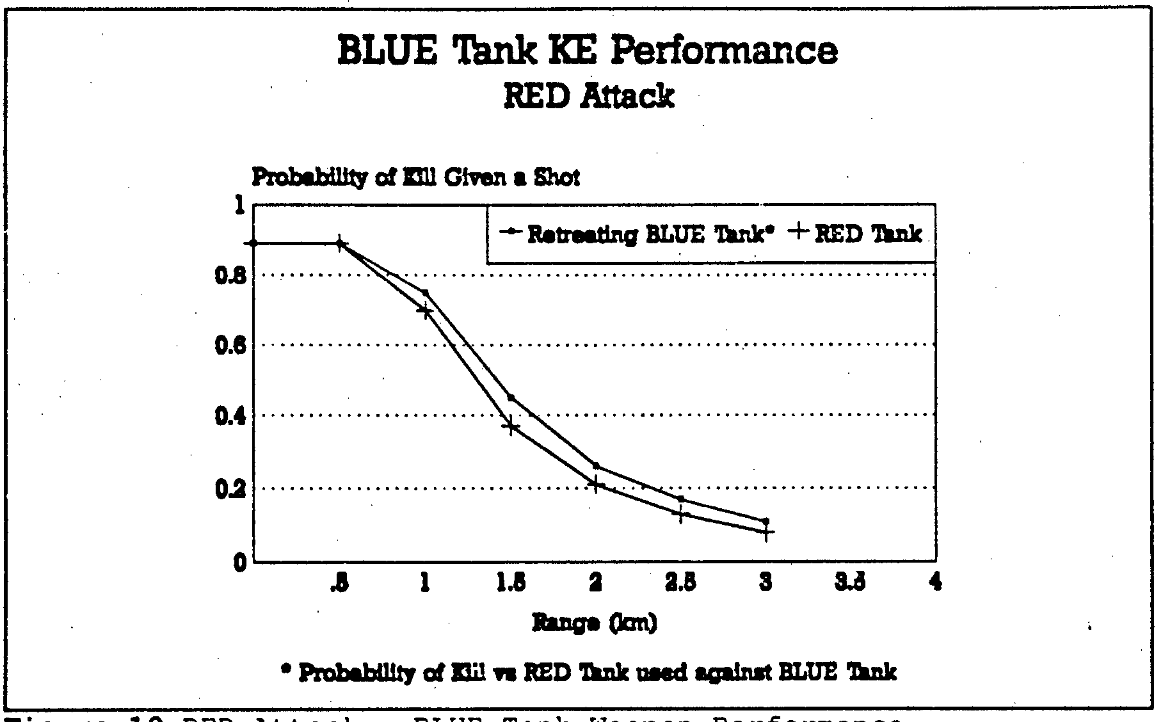

Figure 19 RED Attack - BLUE Tank Weapon Performance

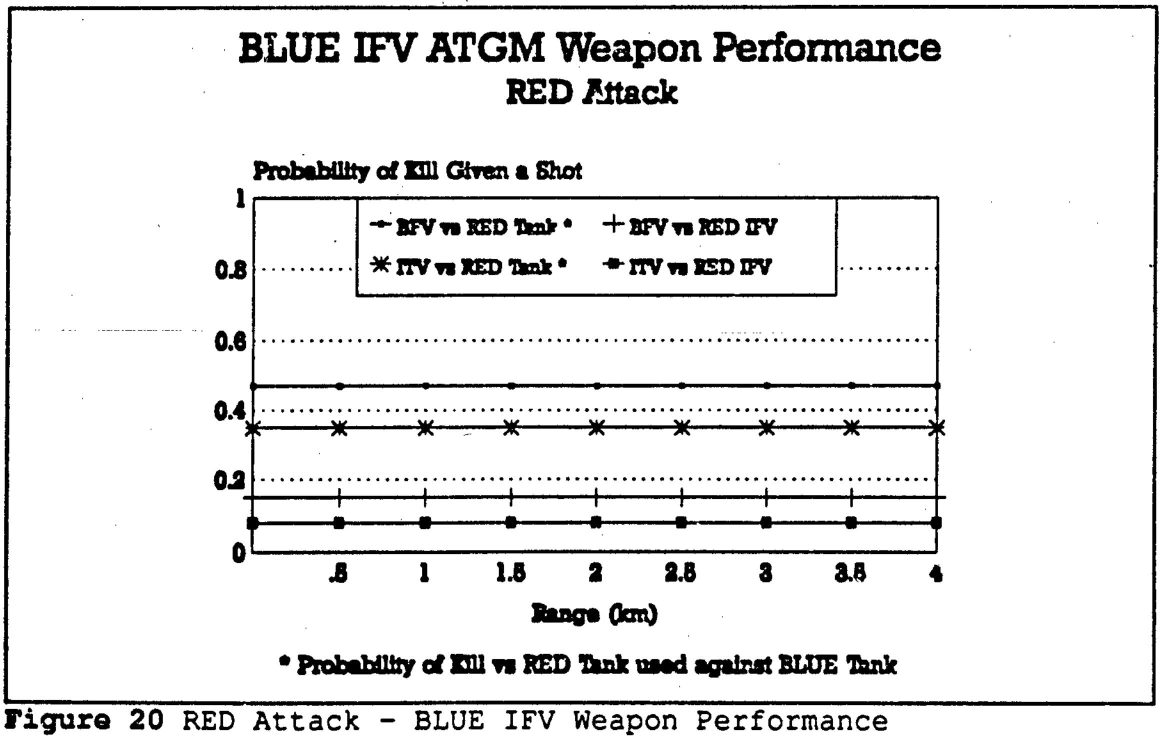

Figure 20 RED Attack - BLUE IFV Weapon Performance

affect their performance (Figure 22). For the three effectiveness levels shown, there is almost no difference between the 0, 2, and 5 second time delay cases. The 10 seconds time delay begins to minimize the benefit which BLUE is getting from deploying the CID. For the 50% effectiveness and 10 second delay, BLUE's exchange ratio is about the same as the base case without CID. In all cases the total numbers of BLUE losses are lower than in the base case.

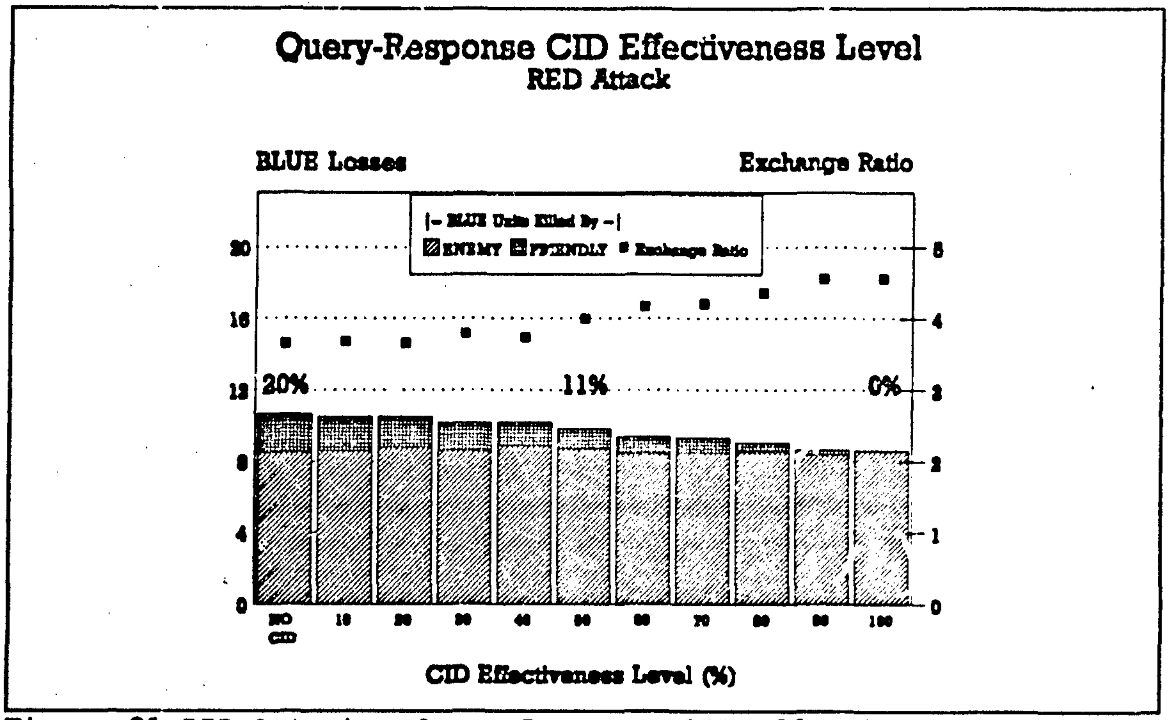

Figure 21 RED Attack - Query-Response CID Effectiveness - GWCS 1

Figure 23 shows the results when the threat was able to detect the friendly target responding to a CID query. There was little change in the results from the CID base cases. The only BLUE vehicles which were responding to CID queries were the retreating tanks. Since the retreating tanks were in close proximity to the RED overwatch, the RED units gained little by being able to detect the CID response. The RED overwatch was already able to detect and engage the BLUE retreating tanks without the added acquisition advantage.

Figures 24 and 25 show the results for the query-response CID under GWCS 2. As with GWCS 1 the friendly fire losses drop steadily as the CID effectiveness increases, but at a faster rate. At the fifty percent CID effectiveness level GWCS1 resulted in 11 percent BLUE friendly fire losses, while GWCS2 reduced this to 7 percent. Similar to the RED Ambush scenario, there is limited

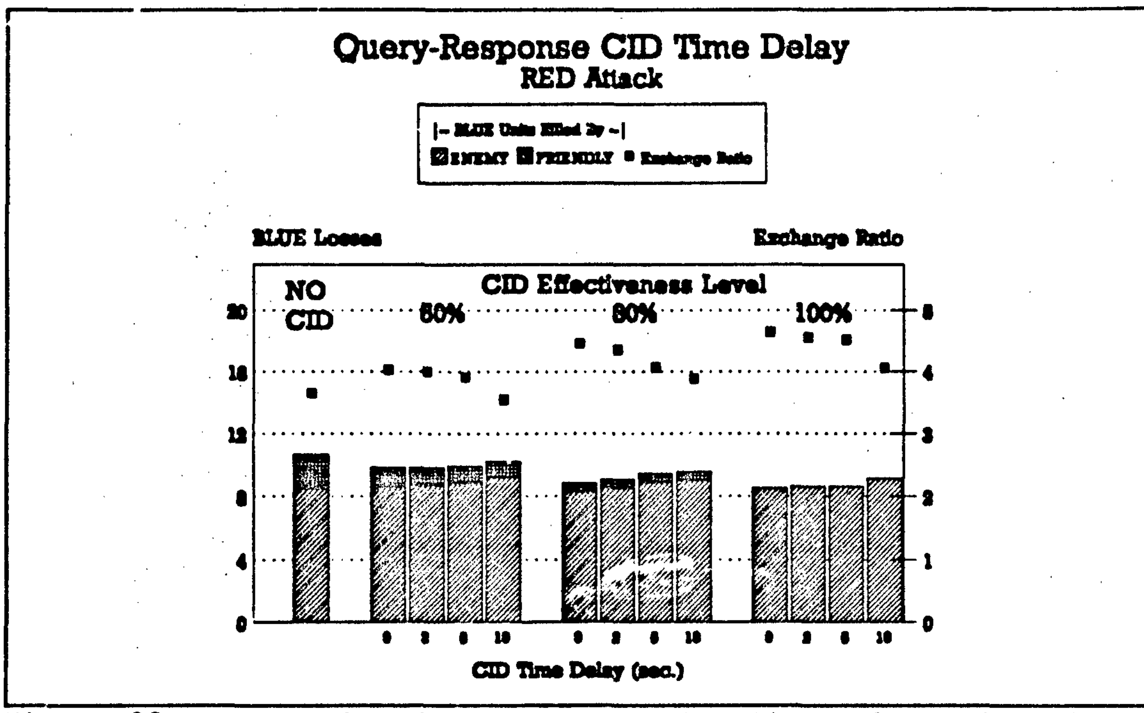

Figure 22 RED Attack - Query-Response CID Time Delay - GWCS 1

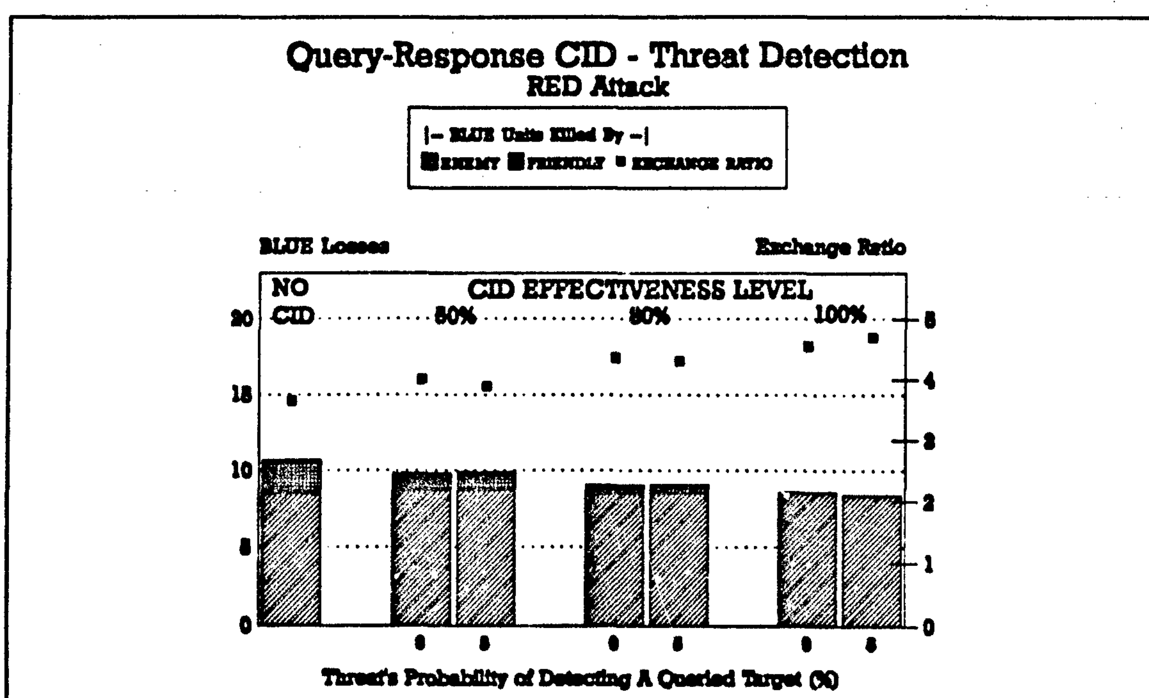

Figure 23 RED Attack - Query-Response CID Threat Cueing - GWCS 1

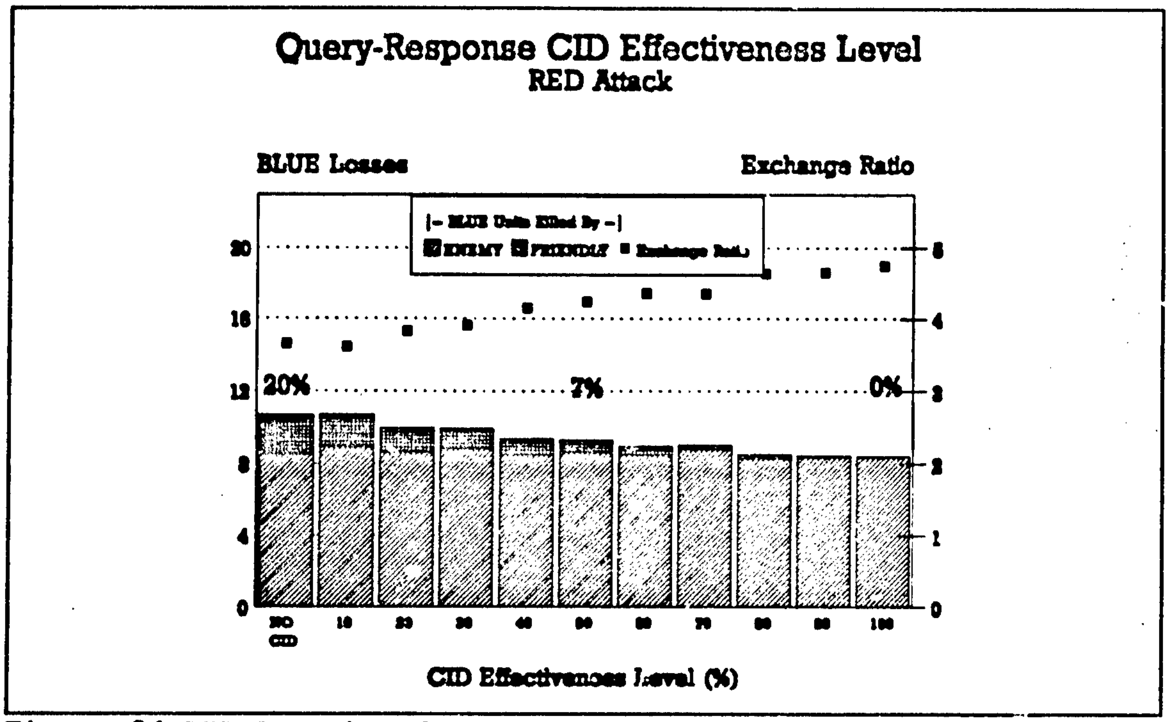

Figure 24 RED Attack - Query-Response CID Effectiveness - GWCS 2

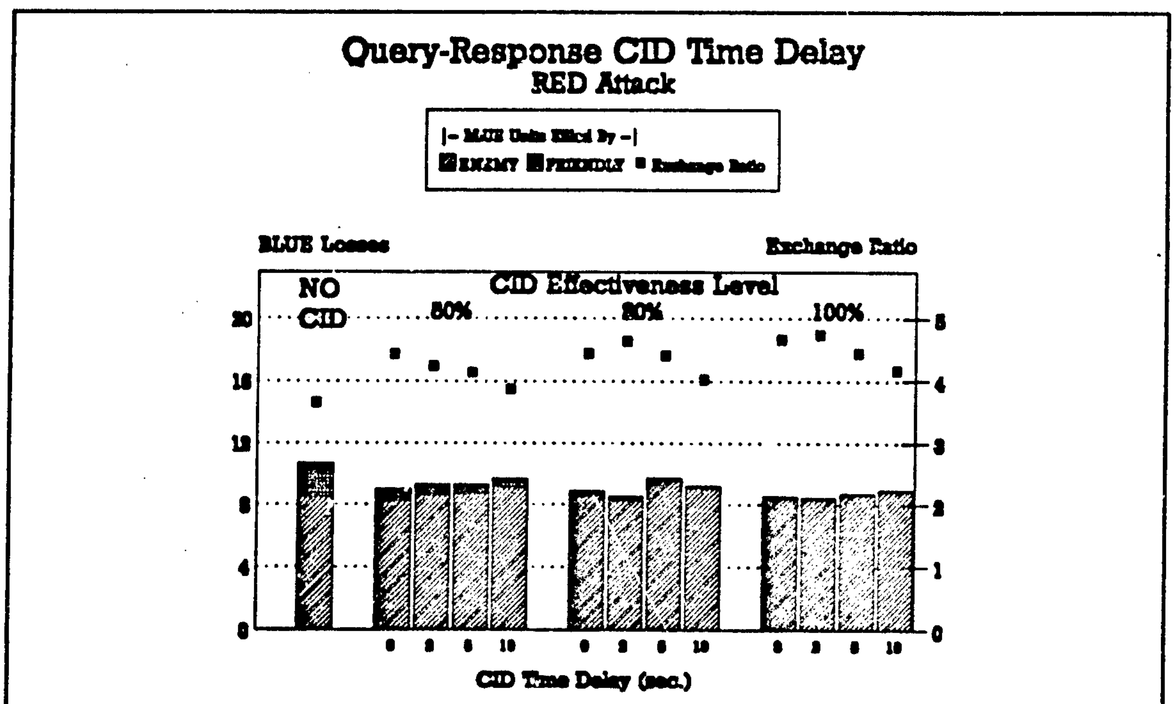

Figure 25 RED Attack - Query-Response CID Time Delay - GWCS 2

benefit to having a CID effectiveness above seventy or eighty percent. Beyond this point, the exchange ratio stabilizes, and the friendly fire losses do not drop significantly.

Variations in the CID time delay under GWCS 2 showed trends similar to GWCS 1. Again there was little difference between the 0, 2, and 5 second time delays. Under GWCS 1, the 10 second time delay with the fifty percent CID effectiveness level resulted in a lower exchange ratio than in the no CID case. With the added benefit of querying a second time, more friendly fire losses were eliminated and BLUE's exchange ratio is higher than the base case. In all CID cases the total BLUE losses are well below the losses sustained in the base case.

Constant Emitter

Figure 26 shows the results of the constant emitter CID in the RED attack scenario. Again the constant emitter CID results are very similar to the query-response CID under GWCS 1. For each level of effectiveness, the total BLUE losses and friendly fire losses are the same between the two CID types. At the fifty percent level of effectiveness, the percent of friendly fire losses drops to thirteen percent, and the exchange ratio is around 4 to 1.

When the threat was able to detect the CID emittance of the BLUE vehicles, BLUE's effectiveness dropped significantly. Recall from the query-response threat detection cases (Figure 23) that there was little impact when the threat was able to detect a target's response to the CID query. This was because only the retreating tanks were being comprimised. For the constant emitter, all of the BLUE vehicles were detectable by the threat (Figure 27). This acquisition aid negated the BLUE defenders' advantage of being in hull defilade and firing the first shot. The CID allowed the threat to detect and engage the BLUE defenders which resulted in increases in BLUE losses to the enemy. This also forced BLUE's exchange ratio below that of the base case.

Figure 28 shows the summary of the different CID types and the Ground Weapon Control Statuses. Again the case at the far left is the case in which the BLUE units will initiate engagement on detection and there is no CID played. As you can see for all of the CID cases, the total BLUE losses are lower than in the base case. The exchange ratio is also higher in each of the CID cases. As was mentioned previously, the constant emitter and the query-response under GWCS 1 produced nearly identical results. The query-response under GWCS 2 resulted in higher exchange ratios and lower friendly fire losses. BLUE's losses to the enemy are constant throughout all of the CID cases and the base case.

The case to the far right is the result of playing GWCS 3. In GWCS 3 BLUE units only engage targets which they can identify as an

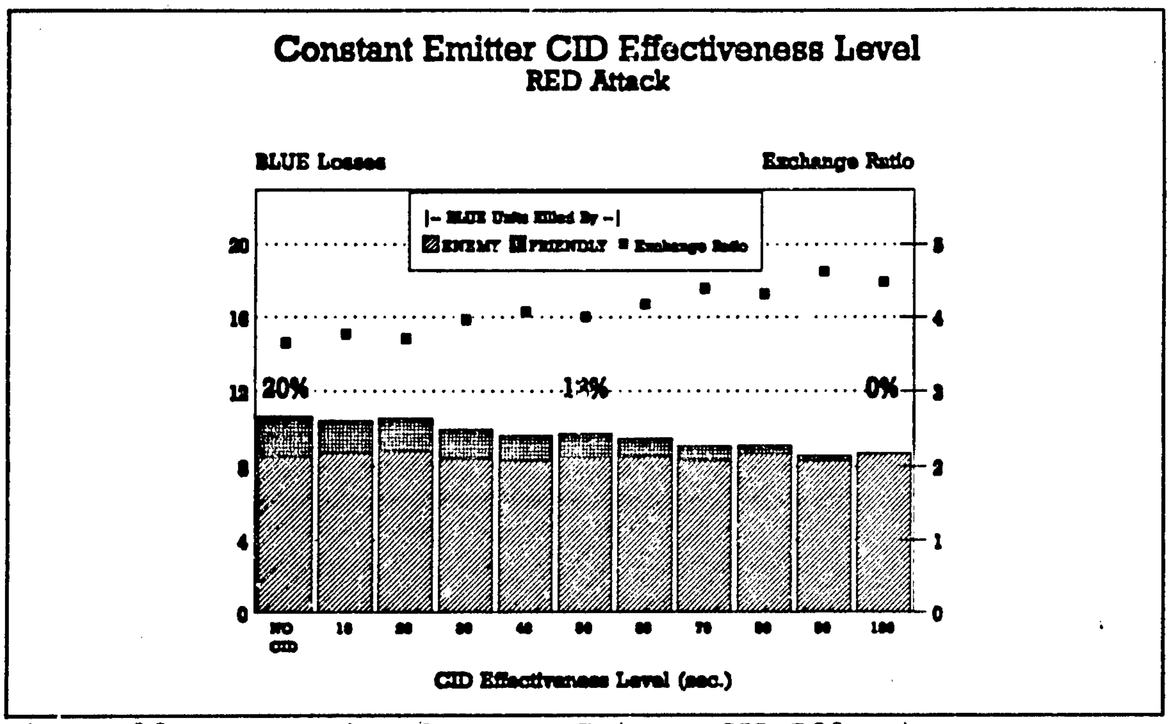

Figure 26 RED Attack - Constant Emitter CID Effectiveness

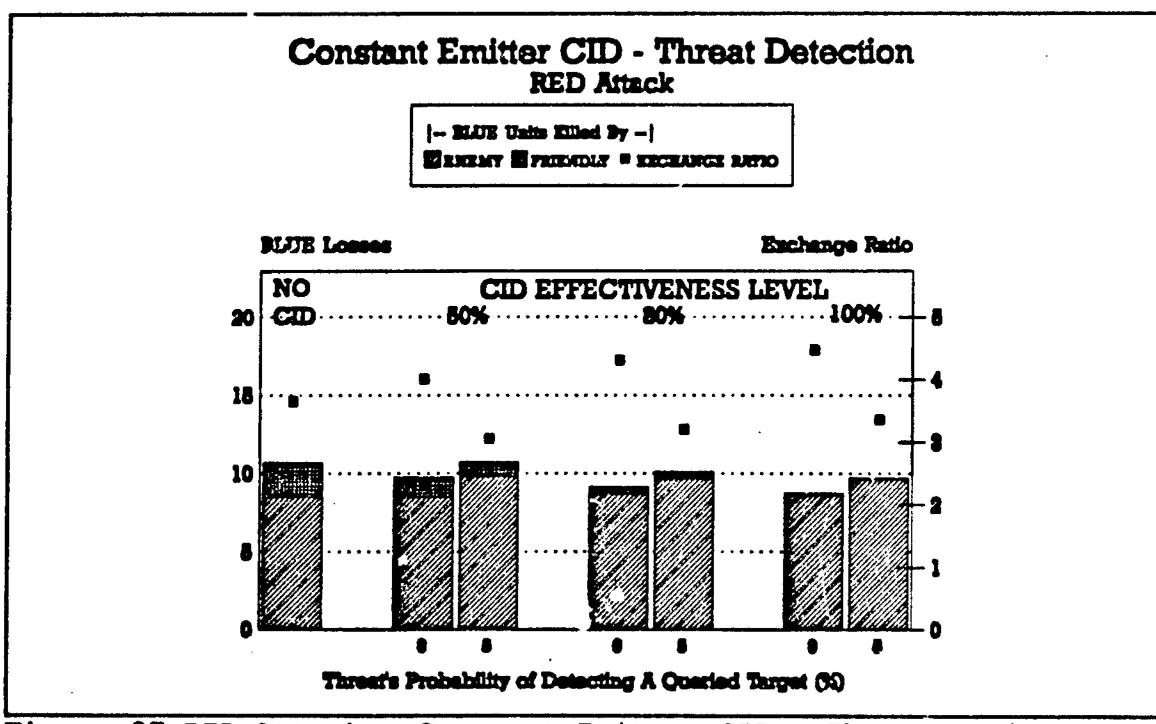

Figure 27 RED Attack - Constant Emitter CID - Threat Cueing

enemy through their sensor. In this case, BLUE does better than under GWCS 1 with no CID. Under GWCS 3 BLUE has eliminated friendly fire losses, but presumably would allow RED to kill more while BLUE waits to identify enemies. This is not the case since BLUE is in hull defilade and hard to see. BLUE can afford to wait until RED closes to the point where BLUE can identify and kill.

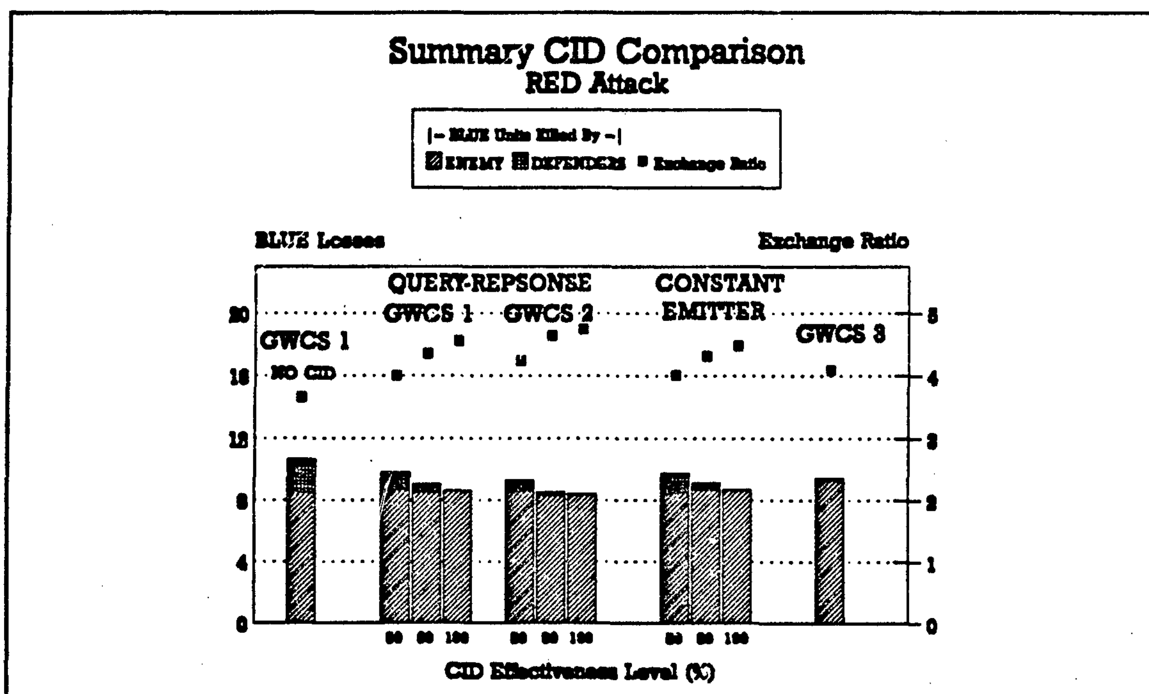

Figure 28 RED Attack - Summary Comparison of CID Types

4. Conclusions

Based on the results shown in this report a number of conclusions can be drawn.

* in situations where there is a potential for friendly losses, combat identification devices can save lives

* the potential for fratricide is highly dependent on the scenario used

* the time delay associated with the query-response CID should be at or below 5 seconds or BLUE's force effectiveness is degraded

* there was little difference in performance between the query-response CID and the constant emitter CID

* when the constant emitter CID is interceptable by the threat, BLUE's force effectiveness suffers due to the omni-directional disclosing effects

* interceptability of the query-response CID is not as serious a problem due to the limited exposure of the CID response.

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GIST

In-House Analysis

SUBJECT: Technical Report No. 534, Friendly Fire and Combat Identification Modeling in Groundwars

PRINCIPAL FINDINGS: Combat Identification Devices reduce fratricide in certain scenarios. The study showed limited difference between a query-response CID and a constantly emitting CID. BLUE's force effectiveness is degraded if the CID lengthens the gunner's engagement timeline by more than five seconds. The benefit of deploying a CID is highly scenario dependent.

MAIN ASSUMPTIONS: BLUE combatants were equipped with combat identification devices (the effectiveness of the devices was examined parametrically). The scenarios included the possibility for fratricide.

PRINCIPAL LIMITATIONS: Only two scenarios were examined. The methodologies incorporated are able to simulate the near term solutions to the fratricide problem. Future solutions may require more model development and study.

SCOPE OF THE EFFORT: Combat simulation methodology improvements. Combat Identification, Fratricide.

OBJECTIVE: To effectively model the deployment of combat identification devices in ground combat. To parametrically evaluate the benefit for the BLUE force in terms of total BLUE dead, friendly fire BLUE dead, and loss exchange ratio.

BASIC APPROACH: The ability of a combat identification device to identify a friendly as such was modeled using a series of Monte Carlo probability draws. The vulnerabilities and susceptibilities of the systems were also modeled. The approach for the study was to execute cases which addressed the scenarios, CID effectiveness, and CID vulnerability parametrically.

REASON FOR PERFORMING THE EFFORT: In response to the friendly fire casualties sustained in Desert Storm, the military community began to develop technologies which would help to reduce fratricide. At the request of SARDA, AMSAA modified the Groundwars model and conducted the parametric study to help to determine the benefit of CIDs.

IMPACT OF THE EFFORT: The methodologies which were developed were incorporated into the CASTFOREM model. The results from the study were used by the customer as an aid in determining operational requirements.

SPONSOR: U.S. Army Materiel Systems Analysis Activity

PRINCIPAL INVESTIGATOR: Michael C. Schmidt

COMMENTS AND QUESTIONS:
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DSN 298-7290, Comm. 1-410-278-7290

DTIC/DLSIE ACCESSION NUMBER: Report sent to DTIC (number not available). Report available by contacting AMSAA's Reports Processing Center, DSN 298-4661.

WHO COULD BENEFIT FROM THIS REPORT: Both U.S. and foreign militaries could use this principle investigation to guide future investigations into the area. The customer has already used the results in determining operational requirements.